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DESIGN, ANALYSIS AND FABRICATION OF ECOKART CHASSIS FRAME

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ABSTRACT

The project is about designing, analysis and fabrication of chassis according to the specifications prescribed in Eco-kart 18 rule book. The go-kart is a small four wheeled vehicles without any suspensions and differential which is light in weight and is used for racing.

The project is intended to percolate the dynamic analysis of go-kart chassis which is of cobbled with circular beams. Modeling operation is performed in SOLIDWORKS and analysis procedure is performed in ANSYS. The analysis is done on static and dynamic loading, deformation and impact on the frame. The go-kart chassis is different from general car chassis as it uses less material for chassis construction and it should be able to withstand loads applied on it. Hence strength and light weight are the basis considerations for a good go-kart chassis material. By taking all the above considerations, the suitable material is Carbon-steel ASTM A106 grade-B, the carbon-steel has – high tensile strength, high machinability and offers good balance of toughness and ductility.

Hence, the chassis is fabricated by bending, cutting and welding the cylindrical beams into the required dimensions and specifications taken into consideration according to the norms given by the Society of Automobile Engineering (SAE-India) for Eco-kart 18.

KEYWORDS: Fabrication, Chassis, Ductility & ANSYS

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Original Article

INTRODUCTION

This chapter it will explains about the project background, project objective, project scope and the project flow that been conducted. conjontly, it also consists of flow chart of the project which unravels the overall grind and how time is being rationed for this project.

Project Background

Go-kart or karting was born from United States in 1950s, where the engine mainly from discarded lawn engine. Go-kart is a driving and racing miniature, skeleton frame, and rear engine automobiles called karts (DiNozzi. B, 1999). Go-kart is a non popular sport previously, but today it has become one of the most popular sports by multiple group age. Now days, racing go-karts are considered as one of the most economic activity where a large number of people can participate. We regularly hear about motorsports racing such as formula one, NASCAR, rally art and many more. Those motorsport activities are out of reach of the average people because of strict regulations and high cost. But apparently, go-kart motorsport gives chances to public to get involved in legal racing with no restricted age and low budget needed. Seven times formula one World Champion; Michael Schumacher started his involvement in motorsports with karting. He joined go-kart motorsports at his hometown,

Germany and won first go-kart championship when he was 19 years old (McCauley. J, 2008). All go-karts look alike, but the fact is go-kart have its own classes such as sprint kart, road racing kart, indoor karting and speedway karting. In 2 addition, with small engine and skeleton frame go-karts speed can reach up to 100 miles per hours and stand a weight up to 210 pounds. In figure 1 show the different between old version go-kart and now day go-kart.

Figure 1: Old Version Go-Kart

The development in karting has expanded rapidly together with advanced technology. As this motorsport become trendy among citizens, those go-karts manufactures avoked to do deeper research and development to recuperate the go-kart in terms of the chassis design, speed, braking system and transmission system. Today is go-kart frames are contrived from agile iron, chromoly and others which is more durable and it can osmoses more vibration even if has no suspension. Designers, engineers and others have tangled directly approaching new achievement in bettering all facets in the go-kart. The usage of upping technology in manufacturing is broadly utilized to prevaricate a better go-kart.

Problem Statement

The problem statement of this project is:

- To improve the skill and knowledge of Mechanical engineering student in designing and importance of project developing go-kart.
- The cost for current go-kart chassis is too expensive

Objective

The objectives of the project are as follow:

- To design a go-kart chassis.
- To fabricate a go-kart chassis.

Scope of Project the Scopes of Project Are as Follow

- Create conceptual design by using solid works.
- Chassis design should bear load of 150kg.
- The go-kart chassis with floor dimension of chassis should be as per ecokart rules.

LITERATURE SURVEY

Introduction

Basically chassis is considered as a framework to support the body, engine and other parts which make up the vehicle. Chassis lends the whole vehicle support and rigidity. Chassis usually includes a pair of longitudinally extending channels and multiple transverse cross members that intersect the channels. The transverse members have a reduced cross section in order to allow for a longitudinally extending storage space. The chassis has to contain the various components required for the race car as well as being based around a driver's cockpit. The safety of the chassis is a major aspect in the design, and should be considered through all stages. Generally, the basic chassis types consist of backbone, ladder, spaceframe and monocoque. Different types of chassis design result the different performance.

Terminology

The propose of car chassis is to maintain the shape of the vehicle and to support the various loads applied to it. The structure usually accounts for a large proportion of the development and manufacturing cost in new vehicle programme and many different structural concepts are available to the designer. It is essential that the best one is chosen to ensure acceptable structural performance within other design constraints such as cost, volume and method of production, product application and many more. Assessments of the performance of a vehicle structure are related to its strength and stiffness. A design aim is to achieve sufficient levels of these with as little mass as possible. (Jason, 2002)

Chassis Design Principle

The fundamental principle of a chassis design states that the chassis is to be designed to achieve the torsional rigidity and light weight in order to achieve good handling performance of a race car. By the definition, torsional rigidity is refers to the ability of chassis to resist twisting force or torque. In the other words, torsional rigidity is the amount of torque required to twist the frame by one degree. These parameters also applied to spaceframe chassis. Generally, the effect of the torsional rigidity on spaceframe is different to the monocoque due to their construction format, but the structure is used to approximate the same results as the difficult to twist monocoque chassis. Figure 2 shows the torsional rigidity applies to race car chassis. (Matt, 1999).

According to the statement above, chassis designed must have high torsional rigidity in order against the twisting force or torque. In order to increase torsional rigidity on the chassis, the format of tube pipes arrangement must be considered. By strategically positioning a frame member, torsional rigidity increase significantly.

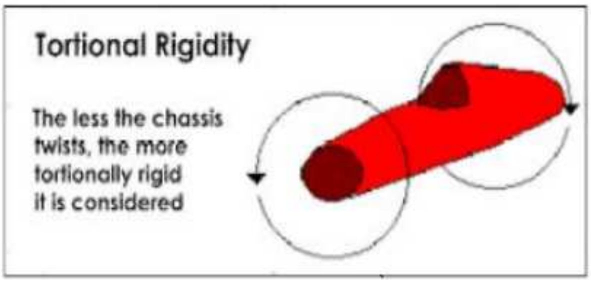


Figure 2: Torsional Rigid of Car Chassis

The triangulated box imparts strength by stressing the diagonal in tension and compression. As shown, the box will not easily deformed by bending force due to the triangulated format of frame.

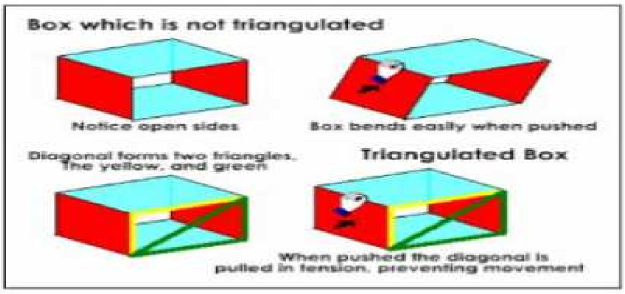


Figure 3: The Strategy on Positioning Space Frame Number

Materials

Different chassis materials can reduce the weight of the vehicle, improving the vehicle power to weight ratio. Material selection can also provide advantages by reducing member deflection, increasing chassis strength and can determine the amount of reinforcement required.

Stainless Steel

Stainless steel is selected as engineering material mainly because of their excellent corrosion resistance in many environments. The corrosion resistance of stainless steel is due to their high chromium contents. In order to make a "stainless steel" stainless, there must be at least 12 percent chromium (Cr) in the steel. According to the classical theory, chromium forms a surface oxide that protects the underlying iron-chromium alloy from corroding. To produce the protective oxide, the stainless steel must be exposed to oxidizing agents. (William, 2006).

Table 1: Mechanical Properties of Stainless Steel

Properties	Value and unit
Ultimate tensile strength	70 MPa
Density	8.0 g/cm3
Modulus of elasticity	200 GPa
Shear strength	152 MPa
Yield strength (0.2% offset)	205 MPa
Melting point	1454 °C
Elongation	35%

Table 2: Typical Composition of Stainless Steel

Element	Value
Ni	11-14
Cr	18-20
C	0.08 max
Mo	3-4
Fe	Balance
Mn	2 max
Si	1 max
S	0.03 max
P	0.04 max

Aluminium

Aluminium is a nonferrous material with very high corrosion resistance and very light material compared to steels. Aluminium cannot match the strength of steel but its strength-to-weight ratio can make it competitive in certain stress application. Aluminium can also be alloyed and heat treated to improve it mechanical properties, which then makes

it much more competitive with steels however the cost increases dramatically. Mechanical properties and typical composition of Aluminium Alloy 6063-T6 is shown in Table 3 and Table 4.

Table 3: Mechanical Properties of Aluminium Alloy

Properties	Value and unit
Ultimate tensile strength	195MPa
Density	2.7 g/cm3
Modulus of elasticity	69.5GPa
Shear strength	150 MPa
Yield strength (0.2% offset)	160 MPa
Melting point	600 °C
Elongation	14%

Table 4: Typical Composition of Aluminium Alloy

Element	Value
Cr	0.1
Fe	0.35 max
Mg	0.45 - 0.9
Mn	0.1 max
Si	0.2
Ti	0.1 max
Cu	0.1max
Al	Balance
Zn	0.1 max

Iron

Iron is a lustrous, ductile, malleable, silver-gray metal (group VIII of the periodic table). It is known to exist in four distinct crystalline forms. Iron rusts in dump air, but not in dry air. It dissolves readily in dilute acids. Iron is chemically active and forms two major series of chemical The main mining areas are China, Brazil, Australia, Russia and Ukraine, with sizeable amounts mined in the USA, Canada, Venezuela, Sweden and India. Mechanical properties and typical composition of Iron (Fe) is shown in Table 3 and Table 4.

Table 5: Mechanical Properties of Iron

Properties	Value and unit
Ultimate tensile strength	70 MPa
Density	7.9 g/cm3
Shear strength	45 MPa
Yield strength (0.2% offset)	53 MPa
Melting point	1538°C
Young's modulus	211 GPa

Table 6: Typical Composition of Iron

Element	Value
C	3.4
Mg	0.06
Mn	0.4 max
Ni	1.0
P	0.1 max

Material Mechanical Concept

Many materials display linear elastic behaviour, defined by a linear stress- strain relationship, as shown in the figure up to point 2, in which deformations are completely recoverable upon removal of the load that is, a specimen loaded elastically in tension elongates, but it returns to its original shape and size when unloaded. Beyond this linear region, for ductile materials, such as steel, deformations are plastic.

After the yield point, ductile metals undergo a period of strain hardening, in which the stress increases again with increasing strain, and they begin to neck, as the cross-sectional area of the specimen decreases due to plastic flow. It is, however, used for quality control, because of the ease of testing. It is also used to roughly determine material types for unknown samples. In Figure 2.7 shows the stress vs. strain curve of a ductile material, at point number one (1) is the ultimate tensile strength, refer to the maximum stress that a material can withstand while being stretched or pulled before necking, which is when the specimen's cross section starts to significantly contract. At point number two (2) is yield strength, explained that the boundary between elastic region and plastic region. At the point number three (3) is point for the proportional limit stress, at this point explained that the amount of stress increasing proportional to the increasing of strain. Fracture occurred at the point number four (4). Fracture is the local separation of an object or material into two, or more, pieces under the action of stress. Lastly at point number five (5) is the offset strain (typically 0.2), this offset use in order to find the yield strength of material.

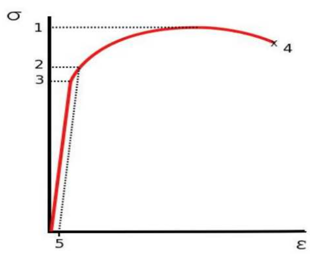


Figure 4: Stress Vs Strain Curve Of Ductile Material

Finite Element Analysis (FEA) Using Algor

Finite Element Analysis (FEA) was first developed by R. Courant in 1943, who utilized the Ritz method of numerical analysis and minimization of variation calculus to obtain approximate solutions to vibration systems. FEA consists of a computer model of a material or design that is stressed and analyzed for specific results. It is used in new product design, and existing product refinement. A company is able to verify a proposed design will be able to perform to the client’s specifications prior to manufacturing or construction. Modifying an existing product or structure is utilized to qualify the product or structure for a new service condition. In case of structural failure, FEA may be used to help determine the design modifications to meet the new condition (Widas, 1997).

METHODOLOGY

Introduction

Methodology can fitly refer to the conjectural analysis of the methods pertinent to the field of musing or to the body of methods and also principles particular to the branch of knowledge. In this sense, one may speak of objections to the methodology of a geographic survey (that is, objections dealing with the appropriateness of the methods used) or of the methodology of modern cognitive psychology (the principles and practices that underlie research in the field). Space frame

more stern to diverse chassis type, this is the rationale race car customarily use space frame chassis. The chassis not precisely just a space frame chassis, but the brew between the monocoque and also the space frame chassis. As the result, driver and engine compartment, the combination reduces the weight of the car. conjecturally, the chassis design notion states that the chassis designed devoir have the triangulated pattern of tubular pipes in order to upsurge the tensional rigidity of the chassis. But for the designing of the prototype car proving space frame chassis for car, it is not vital to pursue this concept because the intent of the design is to have a lightweight car which can cruise hasten by using meager amount of energy. It means that, the car will not go swiftly and not hem the twisting force or torque. The designer will scorn about the principle which is to peck the frame members in a triangulated format as specified before.

The Design Process

The design of the chassis devoir work around a number of criterions and constraints in order to perk well and to be in line to vie in the competition. These requirements can be broken into several categories which will be discussed below. If any of these imperatives are not met, the repercussion ranges from sub-optimal performance to not being elective to vie in the competition or even chassis failure. So it is evident that all imperatives must be attentively considered and even re-evaluted when designing and edifying the chassis.

The engineering design process is the steps of chassis design construction process . In this chapter explain how chassis was designed and how stimulation of the chassis was performed. In this part, explained how chassis is performed. Before the last chassis design got, there are several steps must be considered to make the last result bring the best design. In this part, start from the sketching process, then SOLIDWORKS is used in order to device the miniature of the chassis. The analysis platform used is ANSYS to analyze the, miniature of chassis.

Evaluating

Before start the projects, rough ideas and the steps proposed must be drafted to ensure the project within the planned steps. Evaluation process is important to ensure that the design needed have advantages guided from the current design. The ideas or steps can be gained from the evaluation of the current design (2011).

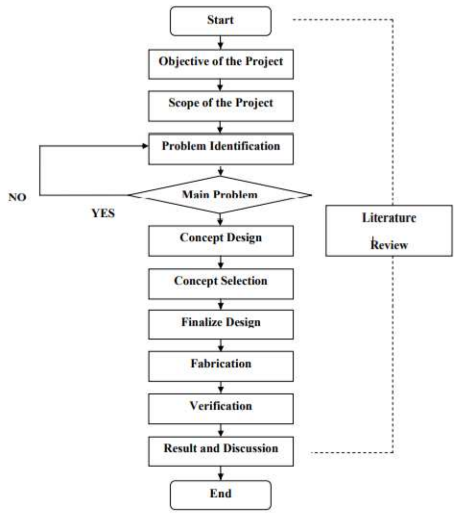


Figure 5: Flow Chart of Methods to Develop Frame

Conceptual Design

The drawing shown that the design shape is frame type chassis. Consist cross shape beam under the driver compartment to support weight of driver and the chassis designed with two tire at front and two tire at the rear or back.

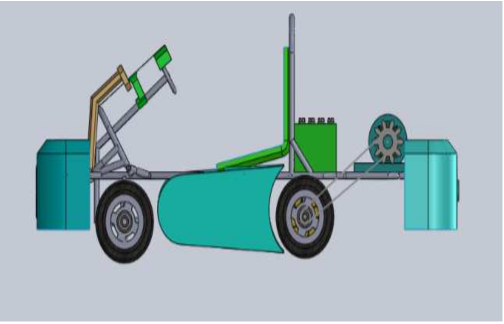


Figure 6: Conceptual Side View

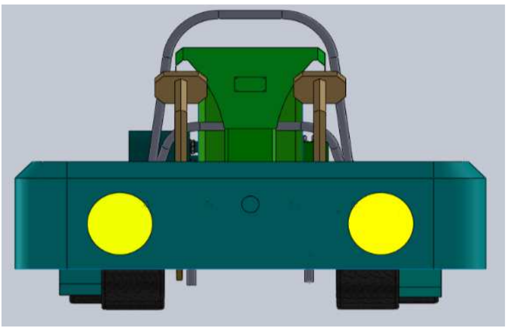


Figure 7: Conceptual Front View

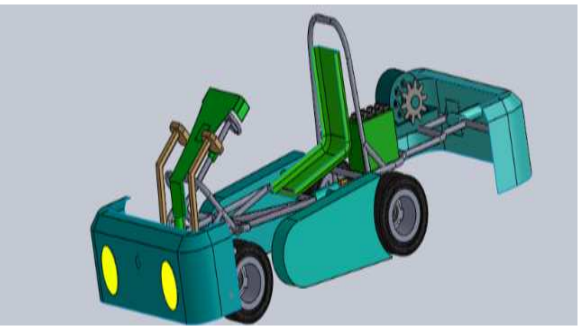


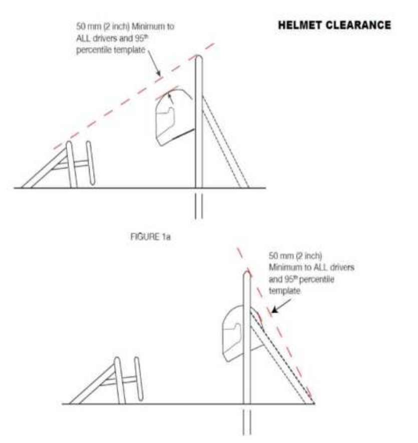
Figure 8: Conceptual View

Roll Over Hoop

The driver's head and hands must not contact the ground in any rollover attitude. The Frame must include both a Main Hoop and a Front Hoop.

When seated normally and restrained by the Driver's Restraint System, the helmet of a 95th percentile male (anthropometrical data) and all of the team's drivers must:

- Be a minimal of 50.8 mm (2 inches) from the straight line peaked from the top of the main hoop to the top of the front hoop.
- Be a minimal of 50.8 mm (2 inches) from the straight line drawn from the top of the main hoop to the lower end of the main hoop bracing if the bracing extends rearwards.)
- Be no further rearwards than the rear surface of the main hoop if the main hoop bracing extends forwards.



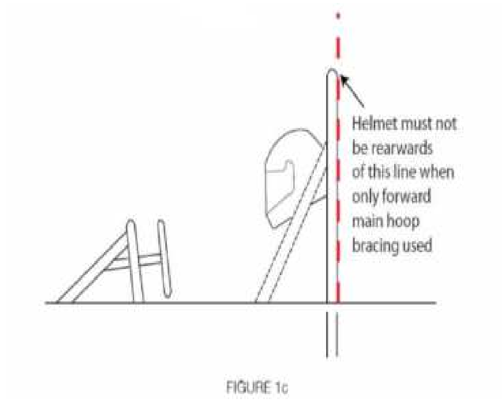


Figure 9: Roll Hoop **Figure 10: Roll Over Protection**

Manufacture Considerations

In order to improve manufacturability, round tubing may be used for frame members. This makes cutting planar joints easier and simplifies suspension mounting points.

On jillion chassis designs a cogent amount of construction bout is taken up by composing jigs to hold the frame in place amid welding. Making a jig is very labor intensive and it can even use as much material as the chassis itself. To enhance the manufacturability of the chassis it must be designed so that it is "self-jigging", which modes that it can be constructed in diverse parts which are then joined together. This significantly reduces the time and material required to make the chassis which greatly reduces the cost. It should be noted that this approach is suitable for a one off process which is the case for the construction of this chassis. Nevertheless if a number of the same chassis are required to be made then the outlay of making a jig is legitimized as it cutbacks the amount of hours required to physique each individual chassis.

Main Hoop

The Main Hoop must be constructed of a single piece of uncut, continuous, closed section steel tubing per Rule. The use of aluminium alloys, titanium alloys or composite materials for the Main Hoop is prohibited. The Main Hoop must go on from the nethermost Frame Member on one side of the Frame, up, over and down to the lowest Frame Member on the other side of the Frame. In the side perspective of the vehicle, the chunk of the Main Roll Hoop that lies atop its attachment link to the Major Structure of the Frame devoir be within ten degrees (10°) of the vertical. In the side perspective of the vehicle, any yaws in the Main Roll Hoop atop its attachment link to the Major Structure of the Frame devoir be braced to a node of the Main Hoop Bracing Support structure with tubing meeting the imperatives of Roll Hoop Bracing as per Rule .11.6 In the front perspective of the vehicle, the vertical members of the Main Hoop devoir be at least 380 mm (15 inch) alone (inside dimension) at the whereabouts where the Main Hoop is affixed to the Major Structure of the Frame.

Main Hoop Bracing

Main Hoop braces must be constructed of closed section steel tubing per Rule. The Main Hoop devoir be supported by two braces spanning in the forward or rearward direction on twain the left and right sides of the Main Hoop. In the side perspective of the Frame, the Main Hoop and the Main Hoop braces devoir not lie on the aforementioned side of

the vertical line by way of the top of the Main Hoop, i.e. if the Main Hoop bows forward, the braces devoir be forward of the Main Hoop, and if the Main Hoop bows rearward, the braces devoir be rearward of the Main Hoop.The Main Hoop braces devoir be attached as adjacent as possible to the crown of the Main Hoop but not more than 160 mm (6.3 in) beneath the highest-most surface of the Main Hoop. The included angle formed by the Main Hoop and the Main Hoop braces must be at least thirty degrees (30°).See the figure. The Main Hoop braces must be straight, i.e. without any bends.

If any item which is farther, the envelope of the Primary Structure is attached to the Main Hoop braces, then extra bracing devoir be added to hamper bending loads in the braces in any rollover attitude.

Table 7

C	Si	Mn	P/S	Cr	Mo	Ni	Cu	V
max	min	req	Max	max	max	max	max	Max
0.30	0.10	0.29-1.06	0.035	0.40	0.15	0.40	0.40	0.08

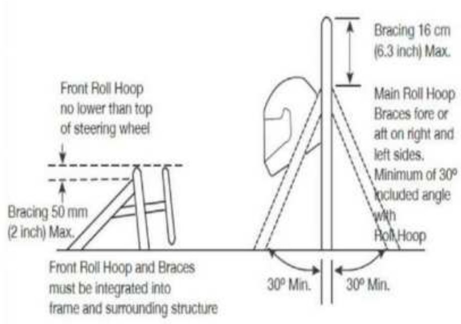


Figure 11: Main Hoop

Selection of Material

ASTM A106 Grade B is a mild steel pipe material commonly used in industrial plants, power plants, refineries and chemical plants. Which is typically seamless and comes in three grades A, B, and C with grade B being the most commonly used grade.It was decided that the frame would be constructed from steel due to its availability and relatively low cost. Lightweight and stiffness are the devoir paramount properties of a chassis and the stiffness of the finished chassis will be overwhelmed by the stiffness of the material from which it is built.

Table 8: Mechanical Properties

Tensile Strength	Yield Strength	Elongation
min(MPa)	min(MPa)	min(%)
415	240	30/16.5

DESCRIPTION: Sunny Steel Supply stocks a full range of A106 seamless carbon steel pipe.

- **Standards:** ASTMA106 (ASMESA106)
- **Products Mainly Used:** apply to bending, curling and similar forming process.
- **The Main Products of Steel / Steel Grade:** Gr.A; Gr.B; Gr.C.
- **Specifications**: diameter: 10.3 to 114.3 mm thickness: 0.8 to 12 mm Length: 6 m above, and, in accordance with customer demand, supply and other specifications of steel pipe.
- JIS Number and Corresponding Foreign Standards

ASTM A106 Seamless Pipe Specifications

In Stock A106 / SA106

- Grade B and C
- Sizes ½" to 8"
- Schedules 40(STD) and 80(XH)

Scope

ASTM A106 Seamless Pressure Pipe (also covered in ASME specifications as S/A 106) is the standard specification for seamless carbon steel nominal wall pipe for high-temperature service. Suitable for bending, flanging and similar forming operations. NPS 1-1/2″ and under may be either hot finished or cold drawn. NPS 2″ and larger shall be hot finished unless otherwise specified.

CHEMICAL REQUIREMENTS

Permissible Variations in Wall Thickness

The minimum wall thickness at any point shall not be more than 12.5% under the nominal wall thickness specified.

Permissible Variations in Weights Per Foot

Weight of any length shall not vary more than 10% over and 3.5% under that specified. NPS 4 and smaller — weighed in lots. Larger sizes shall be weighed separately by length.

Marking on the Pipe

- Manufacturer's name or brand.
- Length of pipe. • A106 A, A 106 B or A 106 C
- NPS Size • Wall thickness or designated Schedule
- Hydrostatic test pressures and/or NDE;
- Heat Number

MODELLING

What is Modelling?

Modelling is basically the art to designing of a structure which is represented in a 3-dimensional space with required shape, dimensions etc. An image made out of clay, wax or something in that form or a pictorial representation of the structure using modern technology such as Auto-CAD, SOLIDWORKS, CATIA etc can be used to represent the design of the structure, for the structure to be good there are some conditions and instructions to be followed:-

- Structural design is the methodical through check of the stability, strength and rigidity of structures.
- The basic objective in structural analysis and design is to produce a structure capable of resisting all applied loads without failure during its intended life.

- The primary purpose of a structure is to transmit or support loads. If the structure is improperly designed or fabricated, or if the actual applied loads exceed the design specifications, the device will probably fail to perform its intended function, with possible serious consequences.
- A well-engineered structure greatly minimizes the possibility of costly failures.
- For the structural design to be a success the material used is a key role played during modelling of the whole structure.

Design Considerations

To design and fabricate an immense performance racing vehicle which will be intact by ergonomically, economically and by all means safety heeds following main parameters were set before the designing; on which whole design process is carried out,

- Driver Ergonomics.
- Serviceability and maintainability.
- Manoeuvrability.
- Design of flexible roll cage.
- Use of optimum power efficiency.
- Cost of the components.

To meet all above considerations and for ease in designing; all systems were designed individually along with mutual specifications considerations for interchangeability.

- Roll Cage
- Steering System
- Braking System
- Powertrain System

Design of the Eco-kart is to be taken into consideration i.e.Design of any component is consisting of three major principles:

- Optimization
- Safety
- Assuage

The main objective of the roll cage is to cater a 3-dimensional protected space over the driver that will foster the driver safe. Its secondary objectives are to foster reliable mounting locations for peripherals, be appealing, low in cost, and low in weight. These intentions were met by culling a roll cage material that has suitable strength and also weighs less giving us an influence in weight reduction. A low cost roll cage was bestowed through material selection and assimilating more continuous members with bends instead of a collection of members welded collectively to cut down manufacturing

costs. The modeling of the roll cage structure is by compassing designing software. This design is validated by Finite Element Analysis. We focused on each point of roll cage to enhance the performance of vehicle without failure of roll cage. We began the task of designing by pervasive research of go kart roll cage through finite element analysis. Our frame's design is shown below;

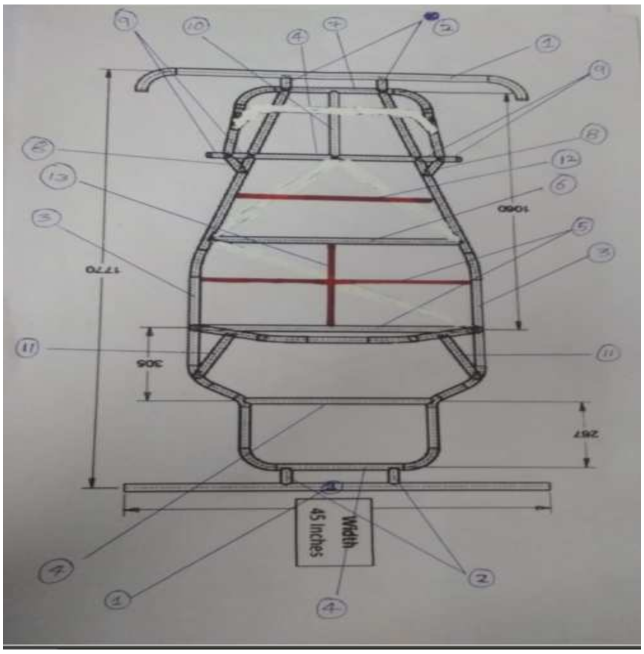


Figure 12: Frame's 2-D Design

Once cad modeling of the frame structure is contrived by using solid works, then this design is investigated by method of Finite Element Analysis. We have used ANSYS (workbench) software for Finite Elemental Analysis RESULT. We first imported the solid works file model in ANSYS (work bench by) IGES Model format, then imparted the properties of material & defined the cross-section of tube created component, then discredited by 3D meshing, and then applied load and finally constrained. The final analysis is shown in ANSYS. We have to lower the deformation and stresses and target to least weight of chassis, the flow chart of entire process is shown in the below figure

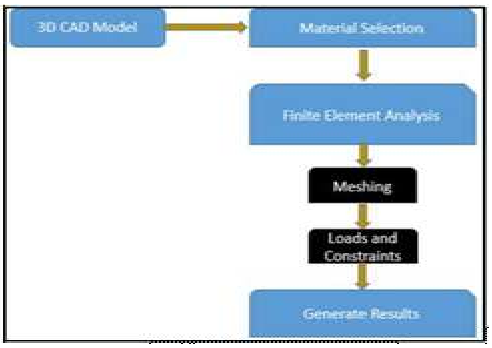


Figure 13: Flowchart if the Process to Get the Final Result

The 2 dimensional view is modified to 3 dimensional model with the help of CAD modelling software.

The CAD modelling software used for our project is SOLIDWORKS.

Figure 14

SOLIDWORKS is a solid modellingcomputer-aided design(CAD) and computer-aided engineering(CAE) computer programthat runs on Microsoft Windows. SOLIDWORKS is published byDassault Systems.

According to the SOLIDWORKS corporate fact sheet, over 3 million engineers and designers at more than 230,000 companies use SOLIDWORKS as of Q4 2015. Worldwide there are 354 Value Added Resellers in 71 countries who sell and support SOLIDWORKS in their local geographies. In addition, there are 740 solution partners who make add-on products to extend the functionality of SOLIDWORKS. In 2015, SOLIDWORKS had revenue of $636 million.

The SOLIDWORKS mission statement: "To provide engineers and design teams with complete, intuitive 3D solutions so they can transform innovation into business success.

Modelling Method

SOLIDWORKS is asolid modeller, and utilizes aparametric feature-basedapproach to create models and assemblies. The software is written onPara solid-kernel. Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allows them to capture design intent.

Design intent is how the creator of the part wants it to respond to changes and updates. For example, you would want the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can. Solid Works allows the user to specify that the hole is a feature on the top surface, and will then honor their design intent no matter what height they later assign to the can.

Features refer to the building blocks of the part. They are the shapes and operations that construct the part. Shape-based features typically begin with a 2D or 3D sketch of shapes such as bosses, holes, slots, etc. This shape is then extruded or cut to add or remove material from the part. Operation-based features are not sketch-based, and include features such as fillets, chamfers, shells, applying draft to the faces of a part, etc.

Building a model in SOLIDWORKS usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of SOLIDWORKS means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside of the sketch.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards (ANSI, ISO, DIN, GOST, JIS, BSI and SAC).

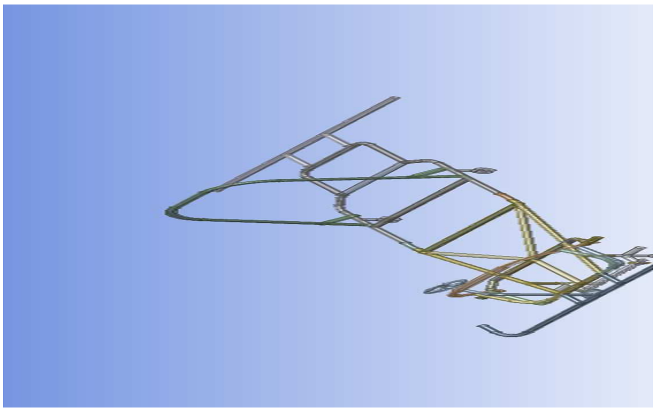


Figure 15: Three Dimensional Representation of Frame

Material Selection

The material selected should be able to withstand all the environmental conditions so that the end product result must be a success but not a failure. Here the structure is the frame and chassis of the Eco-kart. Material selection for chassis is done by comparing different materials on these points and according to the following order of priority: -

- Yield-strength of material should be high.
- Density of material should be low.
- Availability of required cross-sections of material.
- Weldability T.I.G welding based on the following criteria
  - Carbon percentage - should not exceed more than 0.3%, otherwise cracks may appear after SMAW.
  - Manganese percentage - should not exceed 0.8%, otherwise weld bead becomes brittle)
- Other impurities
- Material availability also plays a key role.

The main aim which backups the selecting of various materials and finally concluding by one material for the chassis is to get the overwhelming and safest results considering the driver's safety and real time load bearing capability. The chassis subjects to various forces during its motion, it has to be the same without yielding, and it should be stiff to absorb vibrations, also it has to function greatly at high temperatures. There is no suspension in the go-kart. Therefore, chassis has to be flexible enough to work as suspension and stiff enough not to break or give away on a term. As far as driver's safety is concern the material should have good stiffness and strength. The material property of the chassis is a major criterion while designing and manufacturing the go-kart. A tubular space frame chassis was finalized over monocoque chassis despite being heavier because its manufacturing is cost effective and requires simple tools and damages to t00he chassis can be easily rectified. Tubular sections offer superior loading capabilities per kg when compared to solid sections or square sections.

RESULTS AND ANALYSIS

Meshing (Pre-Analysis)

The meshing is the process of making different components of the frame into one single entity this process is known as meshing and is the most important part for analysis. The meshed object's figure is displayed below

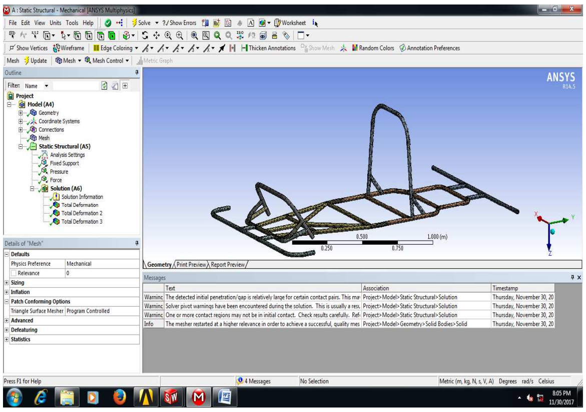


Figure 16: Frame After Meshing Process

FEM(theoretical calculation)

Front impact by assuming that weight of kart including the vehicle(23.37N)+driver is 103.37N.

The total weight is approximately equally to W=103.37N

The total mass i.e. is (mass of kart + mass of man) M=103.37/9.81=10.53kgs

Maximum speed of vehicle V=56.0 KMPH i.e. 56*0.277=15.55m/s

The acceleration of vehicle is a=105.55/13.6=4.11 i.e. a=1.14 m/s^2

Therefore the total force of impact is calculated using formula F=(M*V^2)/d, where d is deformation distance i.e. d=0.5m

F= (10.53*15.55^2)/0.5 we get that is equal to 5092.36KN (approximate) which is applied on the front nodes from front of chassis of vehicle. By assuming the worse condition of crash or hit.

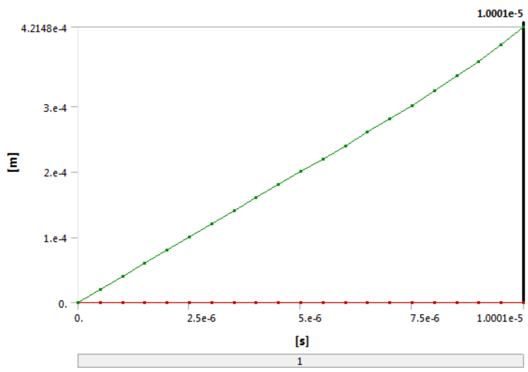


Figure 17: Graph Describing the Impact Analysis (Front)

Calculation From Ansys 1

Table 9: Calculations of Analysis

Time [s]	Minimum [m]	Maximum [m]
1.1755e-038	0.	0.
5.0187e-007		2.0075e-005
1.003e-006		4.0122e-005
1.501e-006		6.0043e-005
2.0022e-006		8.0091e-005
2.5001e-006		1.0001e-004
3.0013e-006		1.2006e-004
3.5024e-006		1.4012e-004
4.0004e-006		1.6004e-004
4.5016e-006		1.801e-004
5.0027e-006		2.0015e-004
5.5007e-006		2.2005e-004
6.0018e-006		2.4007e-004
6.503e-006		2.6023e-004
7.001e-006		2.8042e-004
7.5021e-006		3.0059e-004
8.0001e-006		3.2348e-004
8.5012e-006		3.4683e-004
9.0024e-006		3.6871e-004
9.5003e-006		3.9469e-004

From the above table while the body is moving in forward direction, we can see how the load deforms from time to time and the time history is given from starting of impact load till the end of impact.

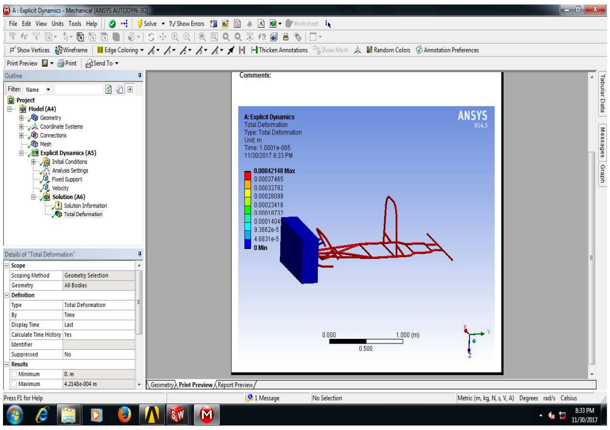


Figure 18: Before Analysing Front Impact

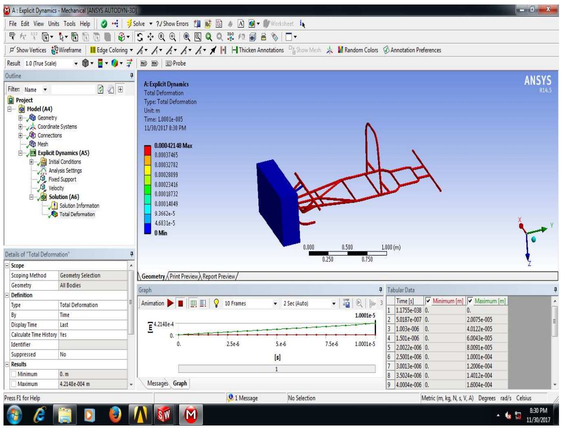


Figure 19: After the Analysis of Front Impact

Reverse speed impact (theoretical calculation)

Rare impact By assuming that weight of kart including the vehicle(23.37N) +driver is 103.37N.

The total weight is approximately equally to W=103.37N

The total mass i.e. is (mass of kart + mass of man) M=103.37/9.81=10.53kgs

Maximum speed of vehicle V=56.0 KMPH i.e. 56*0.277=15.55m/s

The acceleration of vehicle is a=15.55/13.6=4.11 i.e. a=1.14 m/s^2

Therefore the total force of impact is calculated using formula F=(M*V^2)/d, where d is deformation distance i.e. d=0.5m

F= (10.53*15.55^2)/0.5 we get that is equal to 5092.36KN (approximate) which is applied on the front nodes from front of chassis of vehicle. By assuming the worse condition of crash or hit.

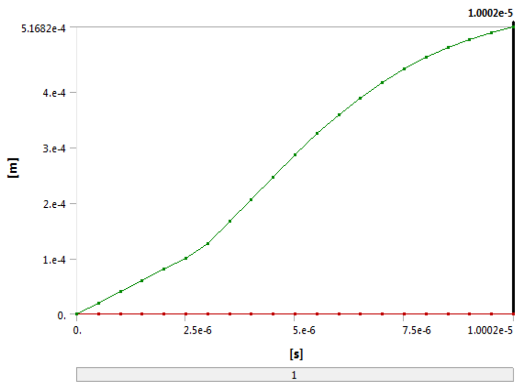


Figure 20: Describing the Impact Analysis (Rare Impact)

Calculation From Ansys 2

Table 10: Calculations of Analysis 2

Time [s]	Minimum [m]	Maximum [m]
1.1755e-038		0.
5.0187e-007		2.0075e-005
1.003e-006		4.0121e-005
1.501e-006		6.0039e-005
2.0022e-006		8.0099e-005
2.5001e-006		1.0005e-004
3.0013e-006		1.2614e-004
3.5024e-006		1.6714e-004
4.0004e-006		2.049e-004
4.5016e-006	0.	2.4657e-004
5.0027e-006		2.8739e-004
5.5007e-006		3.2453e-004
6.0018e-006		3.5852e-004
6.503e-006		3.8915e-004
7.001e-006		4.1634e-004
7.5021e-006		4.4052e-004
8.0001e-006		4.6148e-004
8.5012e-006		4.7958e-004
9.0024e-006		4.9478e-004
9.5004e-006		5.071e-004

From the above table when the body is moving in reverse direction, we can see how the load deforms from time to time and the time history is given from starting of impact load till the end of impact.

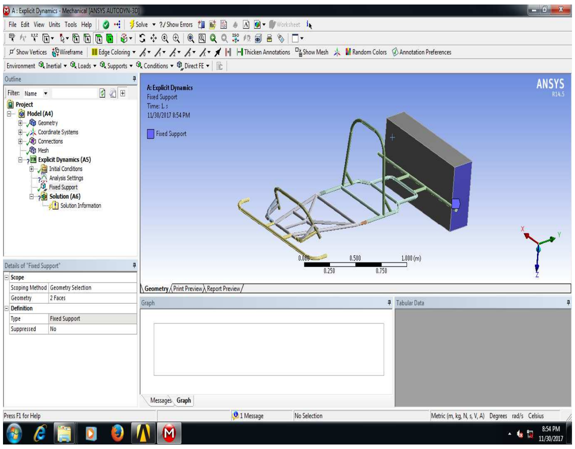


Figure 21: Before the Rear Loading

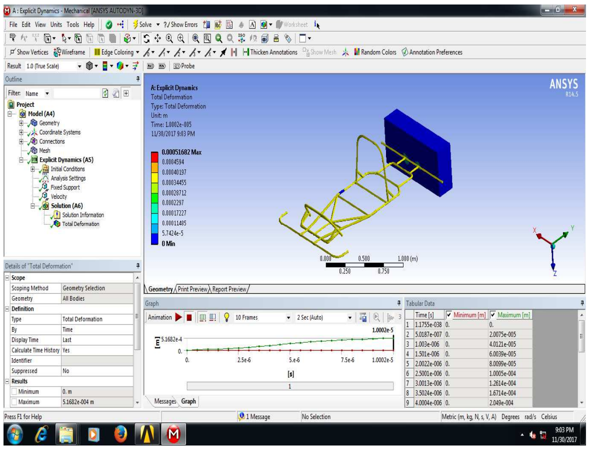


Figure 22: Representing the Analysis After Rear Loading

Centre deformation (due to weight acting at centre of gravity of the frame)

The weights acting are: -

Weight of driver+ the weight of batteries+ power-train's weight = 200N

i.e. total mass M=20.38kgs

total length of the frame=74inches i.e. 74*25.4=1879.6 mm

Bending moment is BM= -W*x (in case of cantilever beam) here x=l/2=1879.6/2

Therefore, BM= - 200/939.8=187960 i.e. **BM=187.96KN**

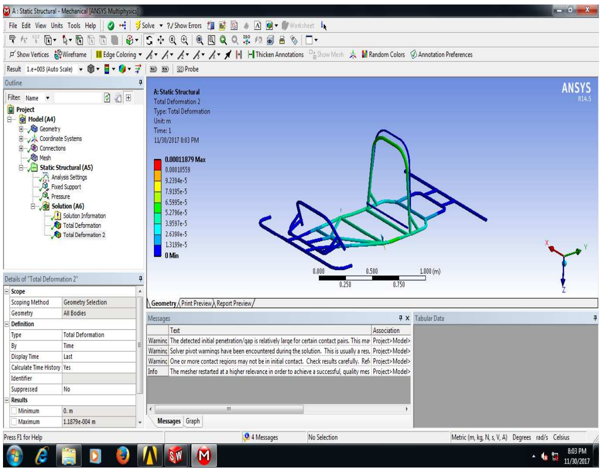


Figure 23: Representing the Centre Loading Analysis and the Bending of the Frame

FABRICATION

Introduction

Fabrication is the act of taking raw stock material and turning it into a part for use in an assembly process. There are many different types of fabrication processes. The most common are different types of machining process:

- Cutting

- Bending
- Grinding
- Athe Work Facing
- Welding

Figure 24: Making as Per Design

RESULT

Hence the results for static and dynamic loading, deflection and impact test are obtained. In our project we have used an BLDC motor which has a very high impacted current consumption, at the rate of 42 amperes at start-up condition because of high torque requirements during start up, but the consumption gradually decreases to 10-12 amperes as vehicle gains speed. So the battery drains out fastly which reduces the overall efficiency. Instead of this to improve the performance high efficiency DC brushless motor can be used which have low current consumption. The mileage of car increased by usinga drive of simple electric motor. We used the straight open kart chassis design. The results show that, alone a electric motor gives 50 to 60 km at speed of 40 kmph on full battery charge. In this project engine replace by electrical motor hence no emission, pollutants and noise can be produced.

CONCLUSIONS

Thus the kart frame chassis was designed using basic automobile principles and it is analyzed by using finite element techniques to know its effectiveness. There were many challenges throughout the design process. The selection of motor to achieve the required starting torque and top speed was a challenging task. Finally a BLDC Motor of 48V and 3KW was selected by conducting both theoretical and experimental studies. To make the kart more effective and efficient in performance, timing chain selected for power transmission is considered to be a master stroke. To exile with an excellent racing kart, the subsystems were designed in such a way that they can achieve paramount performance. Finally, an effective design for the kart is made, which can outperform the existing karts and also in the upcoming era of electric automobile vehicles.

Finally, we succeed to design and fabricate battery powered efficient, single passenger Eco- kart. All the designed components/ systems are safe and performing their intended functions satisfactorily. The Kart travelled a distance of 110 kilometres at a speed of 40 Km/ hour in single charging of four hours. The maximum speed our eco-kart is 70 kmph

Future Scope

The Kart is very feasible for day-to-day travel similar to motorbike. The Kart is much comfortable which supports the driver for easy riding. Mileage efficient vehicle in comparison with any other four wheelers. Very Less weight compared to a small car and comparable to a motorbike. It provides better safety than a two wheeler vehicle. By using a good battery and powerful motor we can make a typical hybrid car which drives with motor in city and on highway it uses internal combustion engine. In cities cars have speed around 40-45 km/ hour

- **ADVANTAGES**
  - It works on electric energy.
  - No need of petrol.
  - It gives better outputs than petrol vehicle.
  - Pollution free working.
  - Easy to drive.
  - It requires low space to park because of its size and its.
  - You don‘t even need to get your oil every 3000 miles
  - Zero emissions at point of use
- **APPLICATION**
  - In school.
  - In colleges.
  - In company campus.

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